FO OUTLOOK
NASA AMES RESEARCH CENTER

Information for the NASA Ames Wind Tunnel Test Community

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First Semispan Test In The 11-Foot Since Modernization

C-5 IN THE 11-FOOT TRANSONIC WIND TUNNEL

By Catalina Ortiz

The Lockheed Martin C-5 test in the 11-Foot Transonic Wind Tunnel was an important step in a modernization program that will help extend the service life of the huge military transport plane.

Code FO personnel tested a 5.7-percent scale semispan model of the C-5 equipped with a high-pressure air driven engine simulator. The May test determined the effects of a new jet engine on the aircraft's performance, stability and control, and structural loads.

The test supported an Air Force effort called the C-5 Reliability Enhancement Re-Engining Program (RERP). RERP is a key element of a modernization program for the C-5, which has carried troops and heavy cargo for the past three decades. General Electric's CF6-80C2 has been chosen as the C-5's new engine.

The C-5 test was the first semispan test in the 11-foot TWT since the integrated systems test (IST), the final stage of the tunnel's extensive modernization.

Test personnel obtained data on the effects of the new engine's jet exhaust pattern at high speeds. They tested engine forward- and reverse-thrust configurations at Mach numbers ranging from 0.3 to 0.9, various nozzle pressure ratios, and model attitudes.

During initial test shakedown runs, severe model dynamics at the higher Mach numbers halted testing. Investigative runs uncovered the source of the problem: the gap between the model and the test-section floor. An air dam was fabricated around the model fuselage nose to reduce induced airflow underneath the model, eliminating the model dynamics.

"After the model dynamics problem was solved, the test ran very smoothly," says test manager Chris Natividad. "I think John Holmberg and the Lockheed model engineer did a great job in determining and resolving the problem so that the test program could be completed."

C-5 Galaxy semispan model installed in the 11-foot test section

The test required precise control of the model turntable and the high-pressure air control system. In addition, Morgan Wright, the FOI test instrumentation engineer, developed a health monitoring system for the customer's turbine-powered engine simulator.

"All the systems worked well, allowing safe test operations and strict test conditions to be maintained. I would also like to

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Serving the Aerospace Industry and Research Community
Wind Tunnel Operations Division
NASA Ames Research Center

ENSURING THE SAFETY OF WIND TUNNEL VISITORS

By Catalina Ortiz

NASA Ames' wind tunnels are more than test facilities that make vital contributions to the development of aircraft. They're also favorite tour sites for visitors to Ames Research Center.

Wind tunnel tours now begin with a safety briefing

Keeping tourists safe, particularly during an emergency, is a high priority for Code FO. Over the past year, the division – with the help of Code Q and the Moffett Field Fire Department – has formalized tour rules, improved signs, and taken a variety of other steps to protect our guests.

"This has been a huge team effort … that has improved safety while keeping the facilities available for visitors," says FO Deputy Chief Dan Bufton. "Yet it hasn't affected tours adversely from the visitor's standpoint."

Hundreds of visitors tour Ames' wind tunnels each year. They include students, teachers, Navy pilots, aerospace engineers, potential customers, and dignitaries on trips to the Bay Area. FO managers and staff lead guests through the National Full-Scale Aerodynamic Complex, the Unitary Plan Wind Tunnel, and the 12-foot Pressure Wind Tunnel.

The extra concern for visitors stemmed from the overall awareness of security and safety following last September's terrorist attacks on New York and the Pentagon. Although Code FO already had programs to protect staff and visitors against everyday hazards, division managers were concerned about tour safety during an emergency – such as a fire, power outage, or major earthquake.

This "Not an Exit" sign blocks a catwalk outside the 80-by-120-foot test section

The challenge was twofold: Visitors are unfamiliar with the wind tunnels, and the wind tunnels weren't built to accommodate visitors. The exits in some parts of the facilities may not be easy to see in the dark. Some stairways are narrow and lead to dead ends. Floors sometimes vary in height and surface. Some areas lack built-in emergency lights. In an emergency, visitors could fall, bump into objects, or take a wrong turn and become lost.

Code FO had rules for tours, but those regulations were informal. So the division decided to make them official and explicit to ensure that everyone – guides and visitors – knows what they are. For example, guides must carry light wands so visitors can see them if the lights go out; visitors must refrain from running, roaming, and touching equipment. Tours now start with a safety briefing.

The division also has increased the number of safety signs and made sure they are easier to see. These include the addition of large exit signs on the first floor of the NFAC below the 40-by-80-foot test section. Before each tour, guides place battery-powered, portable exit signs on their routes. In addition, the division put dozens of large, sticker-like signs on floors to mark paths to exits.

Ron York, a lead mechanic at the NFAC, says that exit decals also were put on some doors at eye level in case smoke obscures the conventional, above-the-frame signs.

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SHIPBOARD ANTENNA TESTED IN THE 80-BY-120

Code FO engineers recently completed a test of Northrop Grumman's AN/SPQ-9B shipboard radar antenna in the 80-by-120-foot Wind Tunnel. Data from the full-scale test will help the Navy put the rotating antenna, which detects and tracks airborne and surface craft, on a wide variety of its ships.

The Naval Research Laboratory wanted to see if the AN/SPQ-9B – a major upgrade of an existing radar system – met its operability requirements. It also wanted to test the performance of the antenna, particularly its rotational speed controller, under different conditions.

The test, conducted in late June, was performed at various speeds from 37 knots to over 95 knots. Engineers ran the tests at various azimuth angles and while the antenna was still and while it was rotating.

The antenna and its base – 77 inches wide and 116.7 inches tall – were mounted on a semispan balance, which was attached to a semispan adapter on the wind tunnel's T-frame. The balance supplied continuous force and moment data, which were obtained for structural analysis of the antenna array and its support.

Test manager Tom Arledge with the AN/SQP-9B antenna in the 80-by-120-foot test section

Engineers used strain gauges to identify material stress in key locations. They also took component temperatures and electronics-performance data to validate the equipment's functionality. Following the Code FO test, Ames' Code A tested the aerodynamic effects of the antenna wake on shipboard aircraft operations.

The Code FO test found that a new speed controller – which enables soft starts of the array rotation at high wind speeds – performed as required after some reprogramming. The test also investigated the effects of different end caps on the sides of the antenna's rotating section, including ones intended to make the antenna less visible to radar.

The AN/SQP-9B track-while-scan system is an upgrade of the AN/SPQ-9 system now used on many Navy cruisers and destroyers. According to Northrop Grumman, the AN/SQP-9B can detect and track antiship missiles flying only a few feet above the water while providing detection and tracking of surface targets and beacon responses. The Navy wants to put the new radar system on a wider variety of ships, including Nimitz-class aircraft carriers.

The Navy, which got the results it wanted and on time, gave Code FO a high rating for the test.

Editor's note: Tom Arledge assisted with this report.

ENSURING SAFETY OF WIND TUNNEL VISITORS

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York highlighted changes in floor height in the test sections – difficult to see in the dark – with lines of bright orange paint. The division also installed chains and "Not an Exit" signs across catwalks along evacuation routes.

Code FO also set limits on the number of people who can go on a single tour; the number varies depending on the facility and number of guides. Guides also have been trained to make sure visitors don't become separated from the group.

The new measures, while making tours safer, have had little impact on the tours themselves.

"The major effect has been on staffing and additional precautions that FO has taken, not on the visitors," says Wind Tunnel Systems Chief Herb Finger, who often leads tours of the facilities.

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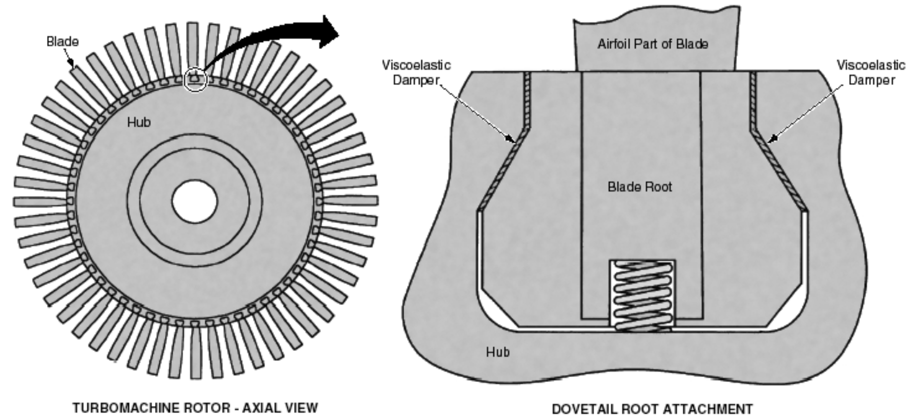
EDITOR: Catalina Ortiz
E-MAIL: cortiz@mail.arc.nasa.gov
PHONE: (650) 604-1161
URL: http://windtunnels.arc.nasa.gov

FO DAMPING PATENT HIGHLIGHTED IN TECH BRIEFS

By Catalina Ortiz



Layers of damping material between the root of the blade and the rotor dissipate vibrational energy, reducing fatigue.

Sometimes stubborn problems have simple solutions. But simple doesn't necessarily mean easy to find.

One example is Nhan Nguyen's straightforward and inexpensive answer to a decades-old problem at the 11-foot Transonic Wind Tunnel. His unique application – using viscoelastic damping material to prevent rotor-blade fatigue – is being highlighted in Tech Briefs magazine. The publication showcases NASA's technologies and product ideas with potential commercial application.

The solution – which can be installed in existing turbomachines as well as built into new ones – previously won Nguyen, a Code FO facilities engineer, a patent and several honors from NASA.

The Problem

Blades on the 11-foot TWT's three-stage compressor had suffered from fatigue ever since the wind tunnel went online in the 1950s. After Nguyen joined NASA in the 1980s, he was charged with finding the source of the fatigue and devising a solution.

In 1991, Nguyen discovered mistuning in the compressor; combined vibrations of the rotor blades and the rotor disk put highly variable stress on the blades, leading to increased fatigue. After his discovery, engineers countered the mistuning by reducing pressure in the wind tunnel when changing the compressor's speed. That solution did reduce stress on the blades – but also increased the amount of time tests required by about 30 percent.

Nguyen then sought a method that would regain the lost productivity. He focused on damping, reducing vibration by dissipating energy. Initially, he thought of drilling bores in each blade and filling the bores with rods coated with damping material. Tests, however, showed little benefit from that method.

A Simple Solution

Nguyen then hit upon a simpler, less costly solution: putting a thin layer of damping material between the roots of the blades and the hub, where the blades dovetail into the rotor.

For a damping material, he used a commercial polyurethane tape generally employed to protect surfaces from abrasion. When the rotor was set in motion, the tape dissipated the blades' vibrational energy, virtually eliminating the effects of mistuning. This let test managers change the compressor's speed without reducing pressure – avoiding the decrease in productivity.

Given the ultimate solution's simplicity, Nguyen was surprised others hadn't thought of it earlier. He thinks he did because he was so focused.

"I was driven to find a way to solve the problem. Then it clicked in my head," he says.

Code FO uses Nguyen's solution both at the 11-foot TWT and 12-foot Pressure Wind Tunnel. While rotor blades at the division's other wind tunnels may be less prone to fatigue, they also could benefit from his damping solution. NASA applied for a patent in 1995, and the patent was awarded in 2000. Nguyen also received a NASA Patent Appreciation Award and a NASA Exceptional Achievement Medal for his accomplishment.

Future Benefit

Because his damping solution has significantly lengthened the fatigue life of the rotor blades, Code FO asked Nguyen to investigate whether it can now inspect and service the blades less frequently. Based on his findings, Nguyen proposed doubling the current 25-hour inspection and 1,200-hour service intervals. Code FO management recently accepted his proposal.

When Nguyen's proposal is implemented, it will increase wind tunnel productivity and reduce a hazard frequency to inspectors, who must squeeze into narrow spaces to examine the blades. It also will enable the 11-foot TWT to continue to operate with the existing compressor blades well into the future.

CODE F BARBECUE

Wind tunnel division staffers joined their R&D colleagues at Chase Park in June to enjoy food and fun during the Code F barbecue.

Code FOO's Diana Barton won the "Survivor" contest, which included a balloon toss, tug of war, and consumption of (Gummi) worms. Diana, above left, accepts her award from Mike Graham of Code FEU.

Photos by Joe Shields

C-5 GALAXY TRANSPORT TEST IN THE 11-FT. TWT

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C-5 Galaxy transport being unloaded.
Photo from Air Force Link http://www.af.mil

acknowledge the great effort and support of the entire test team," Natividad says.

Despite the initial snag that was solved with the air dam, the test was done on time and within budget and gave the customer the data they desired.

The C-5 is one of the largest aircraft in the world. It is nearly 248 feet long, has a wingspan of almost 223 feet, and can carry up to 270,000 pounds of cargo. The front cargo door is unique; it opens when the aircraft's nose swings up like a visor.

The aircraft first went into operation in 1970 and was retrofitted with new wings in the mid-1980s. The new CF6-80C2 engines, which will replace GE TF-39 class engines, are more powerful yet are expected to reduce the C-5's maintenance costs, noise, and emissions.

FO EMPLOYEES AND CONTRACTORS OF THE MONTH

JIM McCUSKER AND LEW MERMELSTEIN

Jim McCusker and Lew Mermelstein were cited for outstanding technical and management contributions to a project to provide electrical power to the Large Rotor Test Apparatus (LRTA) test stand. The LRTA test stand at the National Full-Scale Aerodynamics Center (NFAC) has two 3,000-horsepower electric motors that drive its single rotor shaft. These motors are powered by two motor-generator sets. The project looked for a way to run the two motor-generator sets so they could share the load.

Jim McCusker

Lew Mermelstein

Jim, a Sverdrup Technology Inc. employee, was made project manager in late 1999. Lew, a NASA employee, was responsible for adapting the motor-generator controls for load sharing, an 18-month task completed earlier this year.

Load sharing of the LRTA motor generators was successfully demonstrated in the 80-by-120-foot Wind Tunnel in August 2001. This was an important demonstration of the NFAC's capability to support runway-independent aircraft research testing. The project will be complete following a test in the 40-by-80-foot Wind Tunnel later this year.

MICHELLE FOSTER

Michelle Foster led the relocation of Code FO personnel from N221 to N227. She took complete control of the project and ensured that every detail of the move was considered and properly handled. Michelle worked with the staff to prepare them for the move: with managers to verify final locations, with communications staff to coordinate the transfers of phones and networks, and with movers to make sure that the work was done properly. Michelle's attention to detail paid off in a tremendous way. By all accounts, the moves, completed earlier this year, were carried out flawlessly. Phones and networks were in place, boxes were ready when needed, and new homes were established. Michelle, an employee of Sverdrup Technology Inc., continues to work tirelessly on remaining "clean-up" issues in N221 to ready it for its new occupants. Michelle has again put all her energy into a successful project.

RON YORK

Ron York, a lead mechanic at the National Full-Scale Aerodynamic Complex (NFAC), has been recognized for his excellent suggestions for improving the safe operation of the scissor lift at the 80-by-120-foot Wind Tunnel. The scissor lift is used primarily to reach large models mounted in the test section. Ron first suggested adding permanent wood floor-protection blocks to the lift's stabilizing legs. Previously, the blocks were separate. This required operators to make several trips up and down a ladder between the floor and the lift's controls to place the blocks and lower the stabilizing legs. Ron, a NASA employee, also suggested adding a rung to the bottom of the lift ladder to make it easier to climb. In addition, he suggested putting foot blocks on the sides of the top rung to keep users from slipping. Ron's suggestions were implemented and have greatly improved operator safety. Ron is to be commended for recognizing potential safety hazards, providing a solution, and implementing the solution.